Research Article / Araştırma Makalesi

The Effect of Computer Usage Time on Radial and Ulnar Deviation in University Students

Üniversite Öğrencilerinde Bilgisayar Kullanım Süresinin Radial ve Ulnar Deviasyona Etkisi

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Abstract

Background: The use of technological devices for more than a certain number of hours in daily life causes some anatomical changes in the human body. The aim of this study was to determine the changes that may occur in the range of motion in the wrist depending on the duration of computer use and to perform examinations on the wrist.
Materials and Methods: In the study conducted on university students, a questionnaire was used to obtain demographic information, a tape measure, a manual muscle test, and a universal goniometer with a sensitivity of 1 degree, and measurements were made with 198 volunteer participants. The data and analysis of the study were performed and evaluated with SPSS (Statistical Program in Social Sciences) 25 program.
Results: In this study conducted on university students, an increase in radial and ulnar deviation degrees due to computer use was found ($p<0.05$). A statistically significant difference was found between the groups (those who used computers for less than 3 hours and more than 3 hours) according to the E-sports (E: Electronic) status of the participants ($p<0.05$). There was no statistically significant difference between the groups (those who used computers for less than 3 hours and more than 3 hours) in wrist circumference measurement ($p>0.05$).
Conclusions: We believe that knowing the radial and ulnar goniometric angles of the wrist will guide clinicians in wrist fractures and wrist analysis.

Key Words: Wrist, Radial deviation, Ulnar deviation, Goniometer

Öz

Amaç: Günlük hayatta belirli bir saatten fazla teknolojik cihaz kullanımı insan vücudunda bazı anatomik değişikliklere neden olmaktadır. Bu çalışmanın amacı bilgisayar kullanım süresine bağlı olarak el bileğindeki hareket açıklığında oluşabilecek değişiklikleri belirlemek ve el bileğinde incelemeler yapmaktır.Humerus'un distalinde bazen görülen foramen supratrochleare ve processus supracondylaris nadir görülen varyasyonlardır. Foramen supratrochlearis; fossa coronoid ve fossa olecranon arasında görülebilir. Bazen de foramen yarı saydam olarak görüldüğü için osteolitik bir lezyon olarak tanımlanır ve yanlış teşhise neden olabilir. Bu çalışmanın amacı humerus'taki foramen supratrochlearis ve processus supracondylaris'in Türk populasyonuna ait prevelansını ve morfolojisini tanımlamaktır.
Materyal ve Metod: Üniversite öğrencileri üzerinde yapılan çalışmada 198 gönüllü katılımcı ile yapılan çalışmada demografik bilgilerin alındığı anket, mezura, manuel kas testi ve 1 derece hassasiyette universal gonyometre kullanılarak ölçümler yapılmıştır. Araştırmanın verileri ve analizleri SPSS (Statistical Program in Social Sciences) 25 programı ile gerçekleştirilmiş ve değerlendirilmiştir.
Bulgular: Üniversite öğrencileri üzerinde yapılan bu çalışmada bilgisayar kullanımına bağlı radial ve ulnar deviasyon derecelerinde artış saptanmıştır ($p<0.05$). Çalışmaya alınan katılımcıların E-spor (E: Elektronik) durumuna göre gruplar (3 saatten az ve daha uzun süre bilgisayar kullananlar) arasında istatistiksel olarak anlamlı fark bulundu ($p<0.05$). Bilek çevresi ölçümünde gruplar (3 saatten az ve daha uzun süre bilgisayar kullananlar) arasında istatistiksel olarak anlamlı fark bulunamadı ($p>0.05$).
Sonuç: El bileğinin radial ve ulnar gonyometrik açılarının bilinmesinin bilek kırıklarında ve el bileği analizinde klinisyenlere yol gösterici olacağına inanıyoruz.

Anahtar Kelimeler: El bileği, Radial deviasyon, Ulnar deviasyon, Gonyometre

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Introduction

Nowadays, technology is developing rapidly, and these developments offer us many products that make our daily lives easier, and computers are at the forefront of these products (1). The computers that have entered our lives enable us to do our jobs easily and quickly. As a result, people work long hours in front of the computer. While doing this work, they perform operations such as pointing with the mouse and typing with the keyboard with the help of the upper extremity and hand with continuous and repetitive movements, and they continue their work by standing in a static position while performing these operations (1,2).

These movements performed with the upper extremity are performed with the help of the hand, which is one of the important parts affecting the functionality of the upper extremity. The hand is one of the most used organs in daily life. With the combination of motor and sensory parameters in hand, it provides more meaningful and more effective movements in our daily life activities. In addition, the hand, which is defined as an organ of knowledge and skill, fulfills many functions in our daily life activities (3,4).

The main functions of the hand are reaching, holding/grasping and carrying/lifting. In computer use, it plays a very important role in function and skill. The shoulder, elbow, and wrist joints are important structures in fulfilling the functional function of the hand by ensuring proper positioning of the hand in space. Compared to other body parts, the hand is a complicated region in terms of muscle attachments, bone structures, and neurovascular organization. The wrist, which has a complex anatomical structure, is very important in upper extremity functionality. Bunnell defines the wrist as a key joint and states that the wrist is important in the function of the hand both because it forms a fixed structure and because it provides mobility. Depending on continuous and repetitive use, many physiological and anatomical changes occur in hand and wrist in this process (5).

People use some body parts more frequently and place more strain on them through repetitive motions in both sports and daily life. Overuse also affects bone tissues. Degenerative changes in the bone structure in the continuously used area can cause more severe changes in the muscle and nerve tissue, which we describe as soft tissue. It also causes morphological changes in the used bone, muscle, nerve, and joints. These changes may be positive such as hypertrophy and increased strength in muscles, or negative such as decreased nerve conduction velocity and joint degeneration (6).

It is also known that the continuous and repetitive use of technological products over a certain time in daily life causes some changes in the human body and causes some problems. In this respect, many changes and problems can be seen in body structures due to computer use, which is quite common, especially among young people in the educational age (1). Before using the computer, an ordinary student used to contract different muscle groups by doing many different activities, such as reading and writing. Accordingly, the person's body posture would constantly change. Today, however, the opposite is happening in this process. (2).

The mouse and touchpads we use on computers enable us to use computers more effectively, but they cause repetitive movements in the upper extremities. Depending on the use of these devices, repetitive radial and ulnar deviation (abduction) movements occur in the wrist. (Radial and ulnar deviation: It means moving away from the midline of the hand attached to the wrist towards the radial or ulnar bone) (6,7,8,9).

These movements occur between certain normal openings with the help of joints and muscles in our body. These ranges are called a range of motion (ROM). ROM measurement is widely used in the diagnosis of musculoskeletal diseases and evaluation of the course of treatment. The most frequently referred source for mean ROM values is the American Academy of Orthopedic Surgeons' handbook (10). Most of the studies on range of motion have been conducted in western societies, and we will conduct our study in Anatolian society (8,9).

The aim of this study is to compare radial and ulnar deviation (abduction) values with wrist range of motion in university students with the values of the American Academy of Orthopaedic Surgeons.

Materials and Methods

Our study was carried out on 198 university student volunteers, 84 males and 114 females aged 18-24, who filled out the informed consent form. The consent of the participants for our study was obtained from Malatya Turgut Özal University Non-Interventional Clinical Research Ethics Committee numbered 2022/74. Healthy individuals without any complaints were included in the study. However, the study did not include individuals with any deformity in the wrist or hand using a computer for six consecutive hours or more.

Our study consists of two groups.

1st group; 99 people who use computers for 3 hours or more a day, 48.51% male, 51.49% female (11)

2nd group; 99 people who use computers less than 3 hours a day, 36.63% are male, 63.37 female (12)

In the demographic inquiry, the individuals' age, height, weight, gender, Covid19 history, regular sports habits, daily smoking, and e-sports status (e-sports is a sport based on online games) were questioned.

Measurements

Measurements were made on the participants' dominant hand using a Mouse or Touchpad. In addition, wrist radial and ulnar deviation degree measurements, circumference measurements, and manual muscle test values were recorded.

Measuring the radial deviation of the wrist: Radial deviation is narrowing the wrist angle from the midline to the radial side when the wrist is in the neutral position. According to the American Society of Orthopedic Surgeons, the wrist radial deviation joint range of motion is 20 degrees. Goniometric measurements were measured using a standard universal goniometer with 1-degree sensitivity. The pivot point of the goniometer was placed at the midpoint of the carpometacarpal joint, proximal to the 3rd metacarpal, while the participant was sitting with the forearm pronated and the volar side of the hand supported on the table. The fixed arm of the goniometer is held parallel to the middle of the radius and ulna. The movable arm of the goniometer was kept parallel to the third metacarpal bone, and the participant was asked to move the wrist towards the radial side. The participants' value corresponding to the endpoint of the movement was recorded (Fig. 1) (13).

Measurement of wrist ulnar deviation: Ulnar deviation is narrowing the wrist angle from the midline to the ulnar side when the wrist is in the neutral position. According to the American Society of Orthopedic Surgeons, the wrist ulnar deviation joint range of motion is 30 degrees. Goniometric measurements were measured using a standard universal goniometer with 1-degree sensitivity. The pivot point of the goniometer was placed at the midpoint of the carpometacarpal joint, proximal to the 3rd metacarpal, while the participant was sitting with the forearm pronated and the volar side of the hand supported on the table. The fixed arm of the goniometer is held parallel to the middle of the radius and ulna. The movable arm of the goniometer was kept parallel to the third metacarpal bone, and the participant was asked to move the wrist towards the ulnar side. The participant's value corresponding to the endpoint of the movement is recorded (Fig. 2) (13).

Measurement of wrist circumference: The distance between the lower parts of the styloid process of radius and the styloid process of ulna was measured using a tape measure with 1 mm measurement sensitivity without pressing on the soft tissue. In circumference measurements, the "0" end of the tape measure was wrapped around the left hand and the other side on the right hand, and the number over the “0” point was recorded on the test form (Fig. 3) .

Manual muscle test: It is a test that evaluates muscle strength without using any device. It is based on the evaluation of motion in the context of gravity. Each muscle is tested with this principle (14,15).

- ***5/5 (Full) muscle strength:*** After the tested muscle completes its movement against gravity, it responds with total resistance to the counterforce applied to it.
- ***4/5 muscle strength:*** After the tested muscle completes its movement against gravity, it regenerates even though it can resist the counterforce applied to it.
- ***3/5 muscle strength:*** After the tested muscle completes its movement against gravity, it regenerates without being able to show any resistance to the counter force applied to it.
- ***2/5 muscle strength:*** The tested muscle only completes its movement when the effect of gravity is removed.
- ***1/5 muscle strength:*** The tested muscle can not complete its movement even when the effect of gravity is removed. It can only contracts.
- ***0 muscle strength:*** The tested muscle can not show any movement or contraction. Scoring was done in the value ranges defined in figures (14,15).

In the wrist flexion muscle test, the participant is asked to bring the wrist in the flexion direction, while a value of 4 is given to the submaximal response to the resistance given from the opposite side in the flexion direction and 5 to the maximal response (Fig. 4) (14,15).

In the wrist extension muscle test, the participant is asked to bring the wrist in the extension direction, while a value of 4 is given to the submaximal response to the resistance given from the opposite side in the flexion direction and 5 to the maximal response (Fig. 5) (14,15).

In the wrist ulnar deviation muscle test, the participant is asked to bring the wrist in the direction of ulnar deviation, while a value of 4 is given to the submaximal response to the resistance given from the opposite side in the direction of radial deviation, and 5 to the maximal response (Fig. 6) (14,15).

In the wrist radial deviation muscle test, the participant is asked to bring the wrist in the direction of radial deviation, while a value of 4 is given to the submaximal response to the resistance given from the opposite side in the direction of ulnar deviation, and 5 to the maximal response (Fig. 7) (14,15).

It was applied to the muscles performing the extension, flexion, radial and ulnar deviation movements by giving defined values in the 0-5 range (14,15).

All measurements were repeated three times to reduce the margin of error in the measurements.

Statistical Analysis

The analysis of the data included in the research was carried out with the SPSS (Statistical Program in Social Sciences) 25 program. The Kolmogorov Smirnow Test (14) was used whether the study's data fit the normal distribution. The significance level (p) for comparison tests was taken as 0.05.

Since the variables did not have a normal distribution (p>0.05), the analysis was continued with non-parametric test methods.

Since the assumption of normality was not provided in independent paired groups, comparisons were made with the Mann-Whitney U test. In addition, Kruskal Wallis test analysis was performed for comparisons in multiple inde

pendent groups. Since the p-value will increase depending on the increase in the number of comparisons in the variables with a difference, the Bonferroni corrected p-value was used and calculated with "(0.05/binary comparison)" (16). After the Kruskal-Wallis test, the p values obtained by the Mann-Whitney test are compared with the calculated p values , and the result is decided.

In the analysis of categorical data, chi-square (χ2) analysis was applied by creating cross tables.

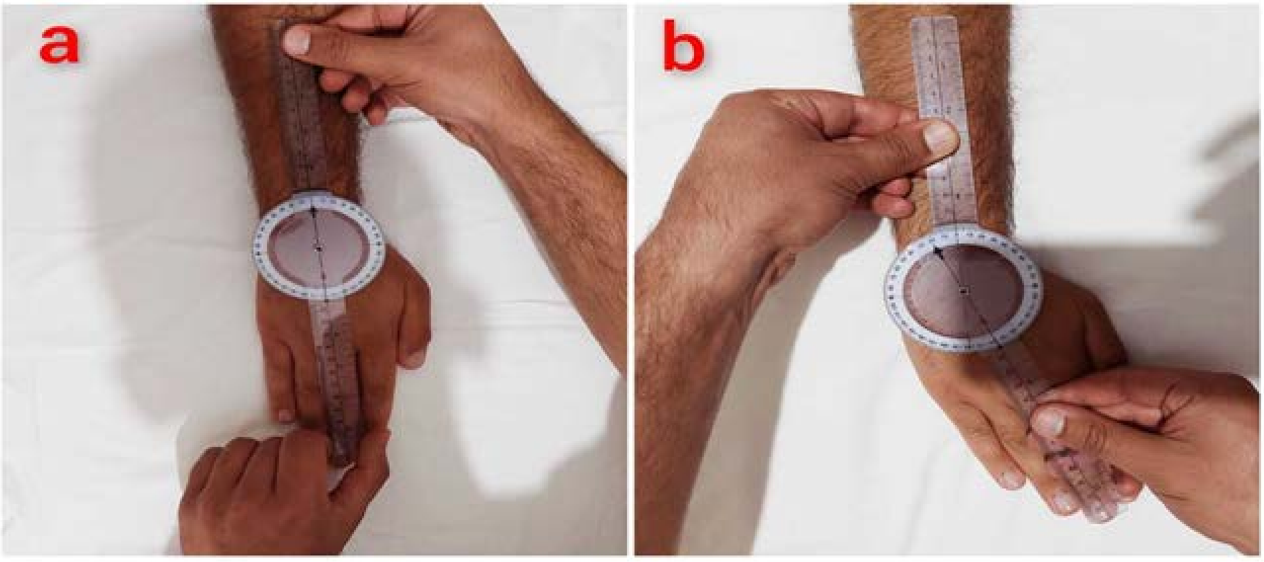

Figure 1 . Measurement of radial deviation of the wrist a: the wrist in the neutral position, b: measurement of the wrist at the end point of the movement in radial deviation

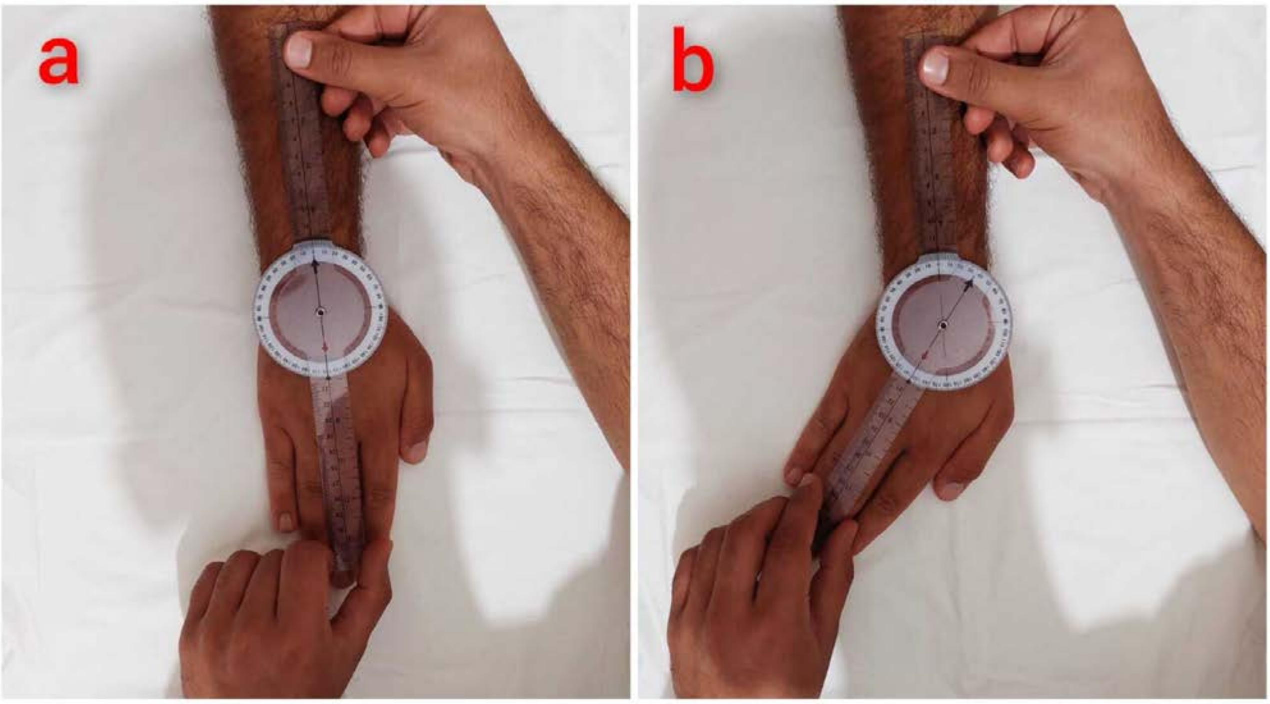

Figure 2. Measurement of wrist ulnar deviation a: wrist in the neutral position, b: measurement of the wrist at the end point of movement in ulnar deviation.

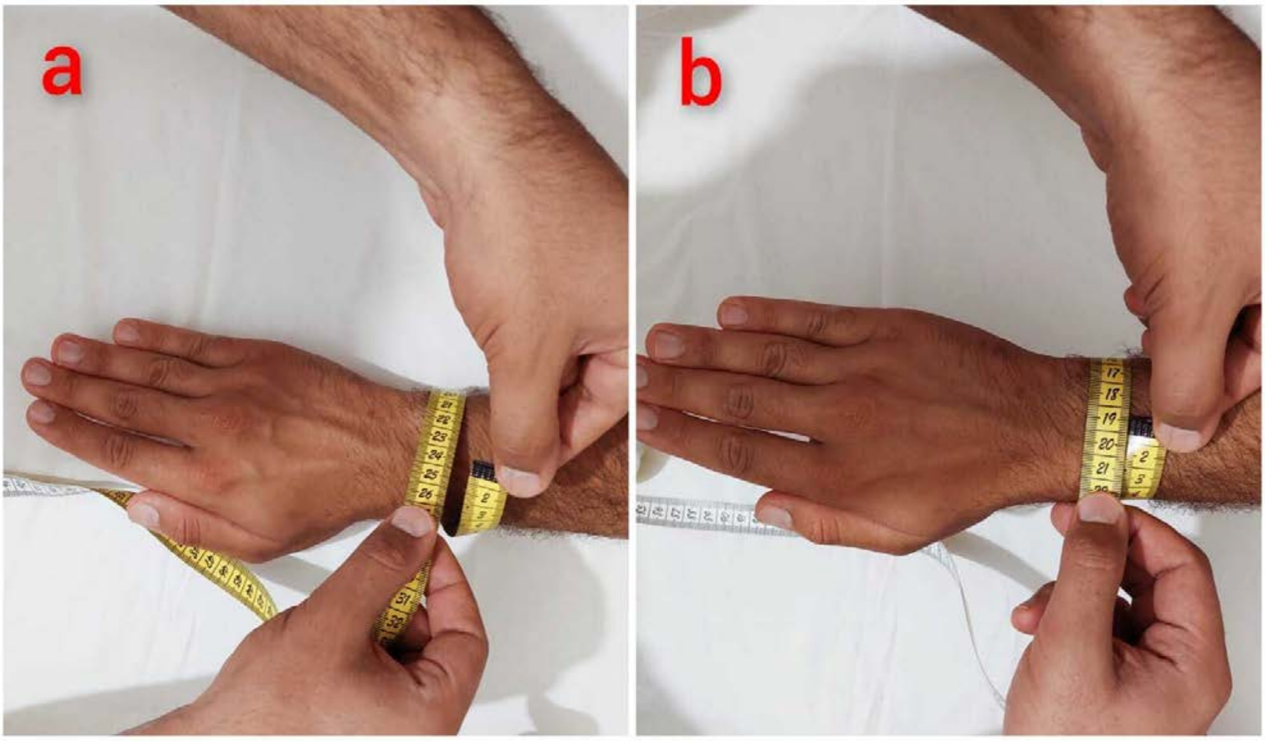

Figure 3. Wrist circumference measurement a: determining the lower part of the processus styloideus radii and processus styloideus ulna, b: recording the number above the “0” point in wrist circumference measurement.

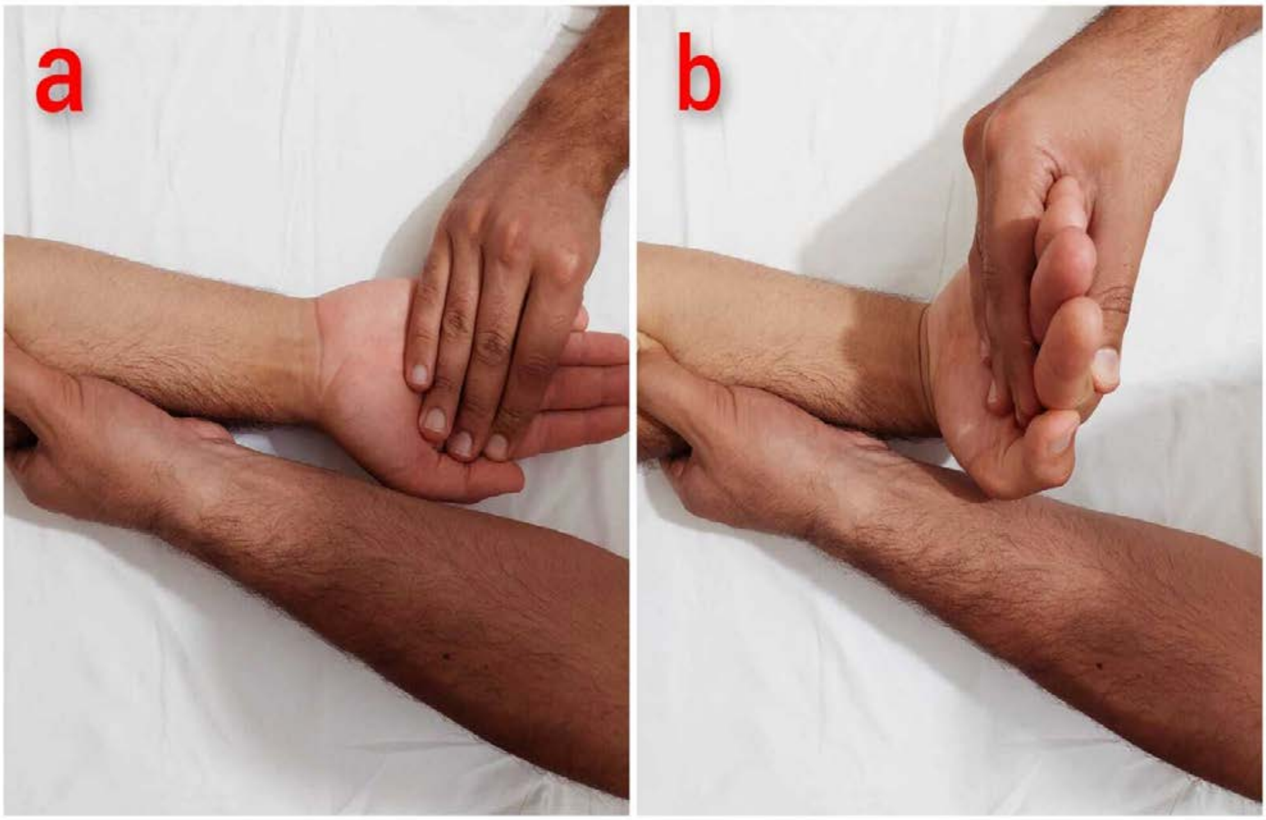

Figure 4. In the wrist flexion muscle test, a: the participant is positioned against gravity in the direction that the wrist will be resisted, b: resistance is given in the direction of submaximal and maximal in the direction of extension while the participant flexes the wrist

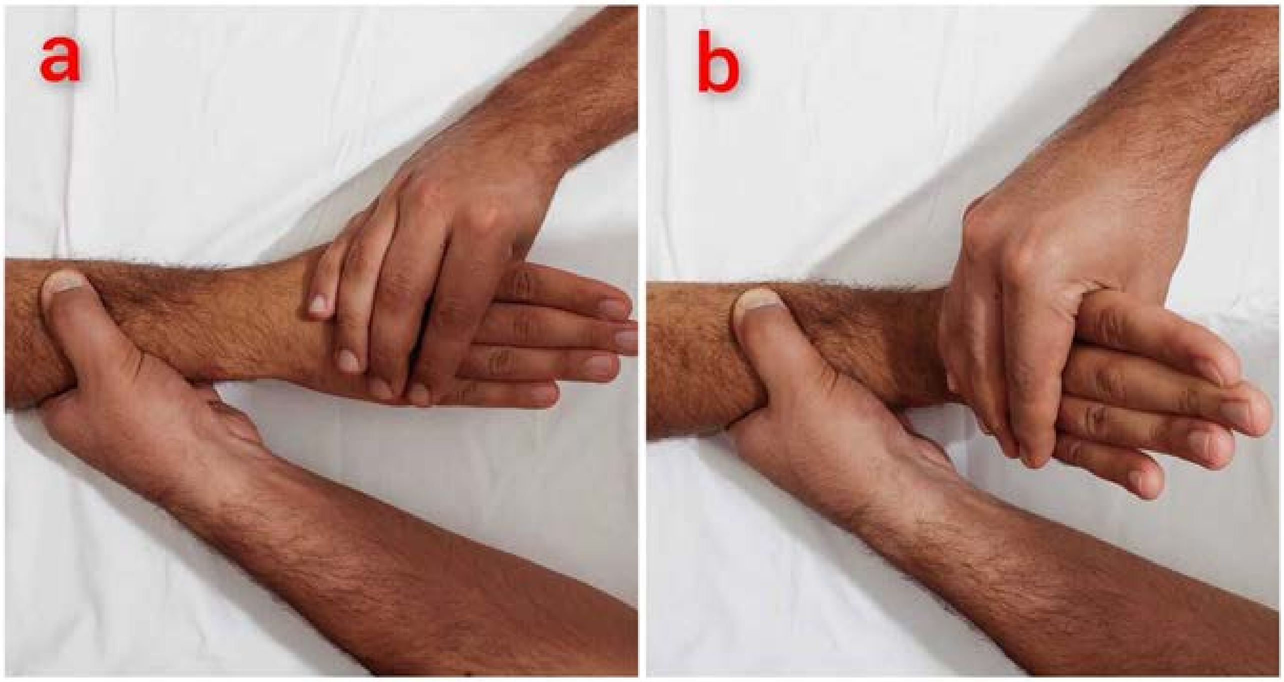

Figure 5. In the wrist extension muscle test, a: the participant is positioned against gravity in the direction that the wrist will be resisted, b: resistance is given in the direction of submaximal and maximal flexion while the participant brings the wrist to extension.

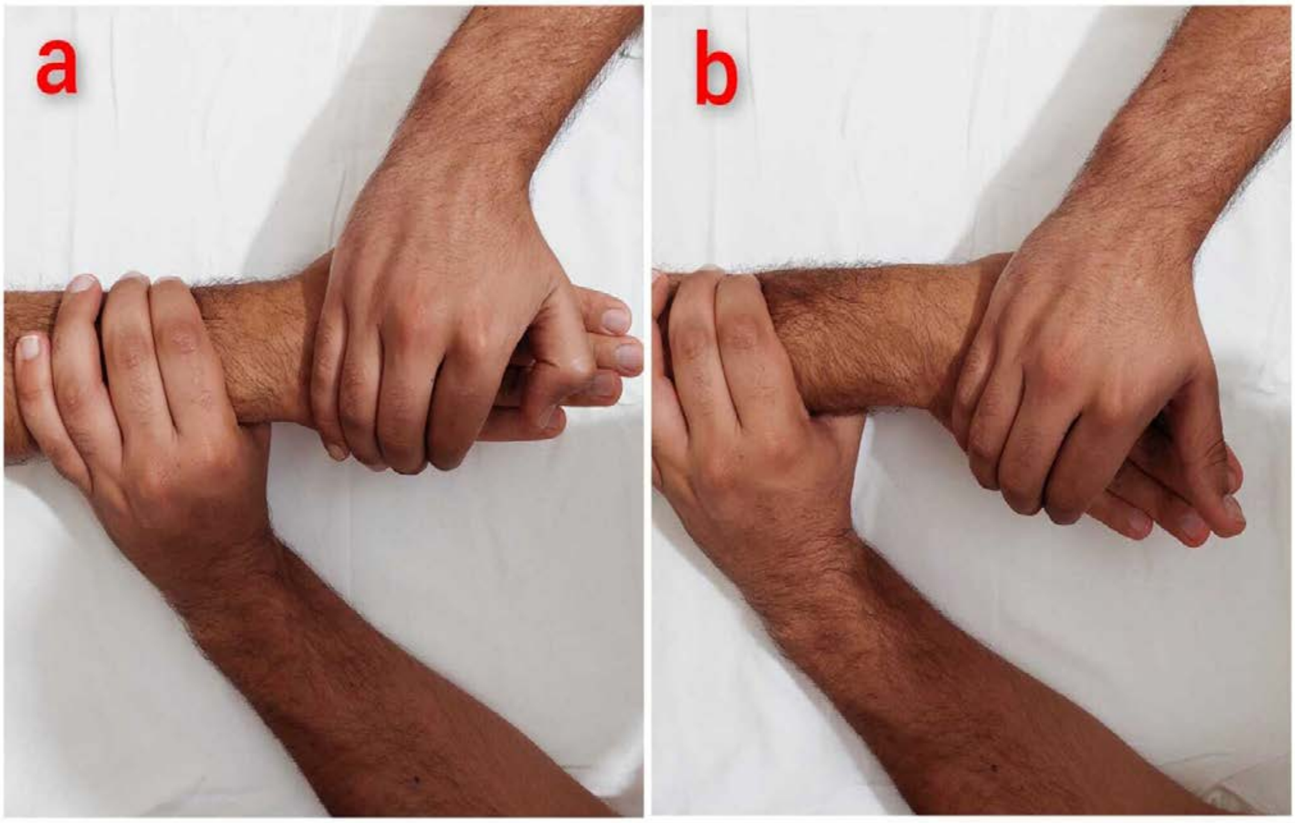

Figure 6. In the wrist ulnar deviation muscle test, a: the participant is positioned to give resistance to the wrist, b: while the participant brings the wrist to the ulnar deviation, resistance is given in the direction of radial deviation, submaximally and maximally.

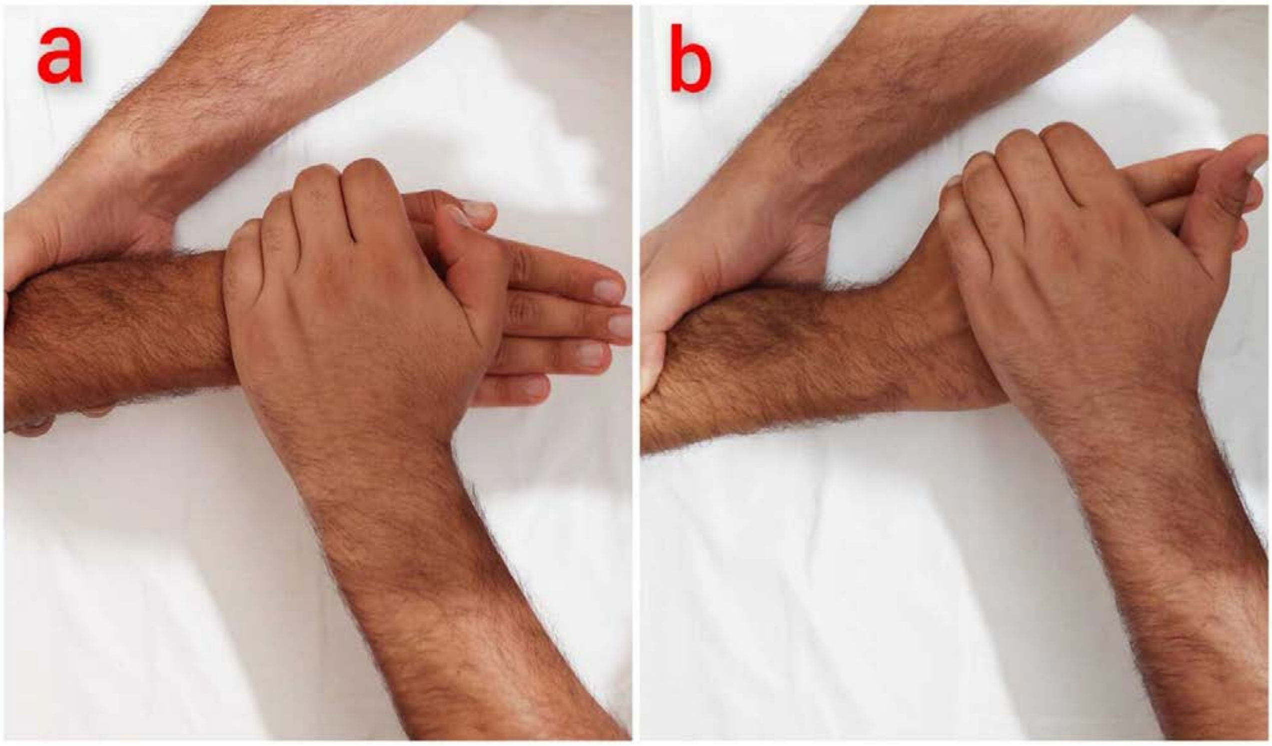

Figure 7. In the wrist radial deviation muscle test, the participant is asked to bring the wrist in the direction of radial deviation, while a value of 4 is given to the submaximal response to the resistance given from the opposite side in the direction of ulnar deviation, and 5 to the maximal response

Results

Evaluation demographic information

Demographic information of the participants included in the study was calculated as numbers and percentages in qualitative data and as mean and standard deviation in quantitative data. The results are given in the table below (Table 1).

There was no statistically significant difference between those who used a computer for less than 3 hours and more than 3 hours according to the variables of gender, chronic disease, smoking, age, and BMI in the participants included in the study (p>0.05).

Participants were homogeneously distributed in groups according to gender, chronic disease, smoking, age, and BMI variables.

Comparison of variables according to groups

It was tested whether the participants included in the study did regular sports or not, the hand using mouse, discomfort in the wrist and e-sports history. The results are given in the table below (Table 2).

Among the groups included in the study, there was no statistically significant difference in whether they did sports regularly, the hand using mouse, and the discomfort in the wrist, among the groups included in the study (p>0.05).

Comparison of wrist tests according to groups

It was tested whether there was a difference between the groups (those who used a computer for less than 3 hours and more than 3 hours) according to the radial deviati degree, ulnar deviation degree, and wrist circumference measurements of the participants included in the study. The results are given in the table below (Table 4).

There was a statistically significant difference between the groups (those who used a computer for less than 3 hours and more than 3 hours) in the measurements of the degree of radial deviation (p<0.05).

A statistically significant difference was found between the groups (those who use a computer for less than 3 hours and more than 3 hours) according to the e-sports status of the participants included in the study (p<0.05).

Comparison of wrist tests according to groups

It was tested whether there was a difference between the groups (those who used a computer for less than 3 hours and more than three hours) according to the wrist flexion manual muscle test, wrist extension manual muscle test, wrist radial deviation manual muscle test and wrist ulnar deviation manual muscle test status of the participants included in the study. The results are given in the table below (Table 3).

No statistically significant difference was found between the groups according to the wrist flexion manual muscle test, wrist extension manual muscle test, wrist radial deviation manual muscle test and wrist ulnar deviation muscle test status of the participants (those who use a computer for less than 3 hours and more than 3 hours) (p>0.05). There was a statistically significant difference between the groups (those who used a computer for less than 3 hours and more than 3 hours) in the measurements of the degree of ulnar deviation (p<0.05).

No statistically significant difference was found between the groups (those who use a computer for less than 3 hours and more than 3 hours) in the measurement of wrist circumference (p>0.05).

Table 1. Demographic information of the participants

Varıable	Group		Less Than Three Hours		More Than Three Hours		Total	Test Value[a]	p Value
Sex	**Female**	**n**	63,000		51,000		114,000	0,123	0,084
		%	0,636		0,515		0,576		
	Male	**n**	36,000		48,000		84,000		
		%	0,364		0,485		0,424		
Chronic Disease	**Yes**	**n**	4,000		10,000		14,000	-0,118	0,096
		%	0,040		0,101		0,071		
	No	**n**	95,000		89,000		184,000		
		%	0,960		0,899		0,929		
Smoking	**Yes**	**n**	37,000		37,000		74,000	0,000	1,000
		%	0,374		0,374		0,374		
	No	**n**	62,000		62,000		124,000		
		%	0,626		0,626		0,626		
Varıable			Avg ± sd	M (Min - Max)	Mean ± sd	M (Min - Max)		Test Value[b]	p Value
Age			20,71 ± 1,69	21(18-24)	22,11 ± 3,44	21,91(15,99-33,46)		4259,500	0,111
BMI			20,35 ± 1,65	20(18-26)	47,19 ± 245,09	22,83(15,63-2460,94)		4358,500	0,175

n; number, %; percent, Avg; average, Test value[a]; Chi-square Test Value (χ^2) sd; standart deviation, Min; minimum point, max; maximum point, test value[b]; Kruskal Wallis Test Value ,p value; statistical significance

Table 2. Comparison of Variables According to Groups

Varıable	Group		Less Than Three Hours	Three Hours or More	Total	Test Value	p Value
Doing sports regularly	Yes	n	26	36	62	-0,109	0,125
		%	26,30%	36,40%	31,30%		
	No	n	73	63	136		
		%	73,70%	63,60%	68,70%		
Hand using Mouse or touchpad	Right	n	91	92	183	-0,019	0,788
		%	91,90%	92,90%	92,40%		
	Left	n	8	7	15		
		%	8,10%	7,10%	7,60%		
Discomfort in the hand or wrist	Yes	n	0	1	1	-0,071	0,316
		%	0,00%	1,00%	0,50%		
	No	n	99	98	197		
		%	100,00%	99,00%	99,50%		
E sport history	Yes	n	10	38	48	*-0,330*	*0,001**
		%	10,10%	38,40%	24,20%		
	No	n	89	61	150		
		%	89,90%	61,60%	75,80%		

*n; number, %; percent, Test value; Chi square test value (χ^2), ,p value; statistical significance, *p<0,05; There is statistical significance between the variables.*

Table 3. Comparison of Wrist Tests According to Groups

Variable	Group		Less Than Three Hours	Three Hours or More	Total	Test Value	p Value
wrist flexion manual muscle testing	Good	n	4	1	5	0,097	0,174
		%	4,00%	1,00%	2,50%		
	Normal	n	95	98	193		
		%	96,00%	99,00%	97,50%		
wrist extension manual muscle testing	Good	n	2	6	8	-0,103	0,149
		%	2,00%	6,10%	4,00%		
	Normal	n	97	93	190		
		%	98,00%	93,90%	96,00%		
wrist radial deviation manual muscle testing	Medium	n	1	1	2	0,105	0,332
		%	1,00%	1,00%	1,00%		
	Good	n	6	12	18		
		%	6,10%	12,10%	9,10%		
	Normal	n	92	86	178		
		%	92,90%	86,90%	89,90%		
wrist ulnar deviation manual muscle testing	Good	n	4	2	6	0,059	0,407
		%	4,00%	2,00%	3,00%		
	Normal	n	95	97	192		
		%	96,00%	98,00%	97,00%		

n; number, %; percent, Test value; Chi square test value (χ^2), ,p value; statistical significance

Table 4. Comparison of Wrist Tests by Groups

Measurements**	Groups	Avg± sd	M (Min - Max)	Test	p Value
Radial Deviation Degree	**Less Than Three Hours**	**22,09 ± 5,3**	**21(11-41)**	***2726,500***	***0,001****
	Three Hours or More	25,91 ± 5,06	26(12-42)		
Ulnar Deviation Degree	Less Than Three Hours	33,11 ± 5,65	33(20-48)	*2269,000*	*0,001**
	Three Hours or More	39,27 ± 6,09	40(23-52)		
Wrist Circumference Measurement	Less Than Three Hours	161,54 ± 15,52	158(135-207)	4530,000	0,361
	Three Hours or More	162,6 ± 13,23	161(136-191)		

*sd; standart deviation, Avg; average, Min; minimum point, max; maximum point, test value; Mann Whitney Test Value, p value; statistical significance, *p<0,05; There is statistical significance between the variables.*

Discussion

The American Academy of Orthopaedic Surgeons' handbook is one of the oldest and most widely used sources for normal range of motion. There are very few studies in the literature investigating normal range of motion in healthy individuals (7,17,18). These studies were mostly conducted with a sample group close to our participants. Kouyoumdjian et al. studied 120 volunteer participants for the clinical evaluation of hip rotation in adults. Roaas and Andersson reported that they measured range of motion at the hip in 105 subjects, range of motion at the knee in 90 subjects, and range of motion at the ankle in 96 subjects (19,20). We performed our study in 198 volunteer participants.

When the studies in the literature were examined, we did not find enough information about the age, gender, race, etc. of the population in which the measurements were performed (7,21). Most of the existing studies are based on measurement data in carpal tunnel syndrome, wrist fractures, lymphedema and various neurologic disease states. Different results have been reported in the literature regarding the relationship between gender and normal range of motion. Svenningsen et al. and Beighton et al. reported that hip movements were more in women (22,23). However, Fairbank et al. and Allander et al. found no difference between men and women in terms of hip movements (24,25). In our study, we found that gender had no effect on normal range of motion.

When the BMI results of our study were compared with other examples in the literature, Ake et al. reported that a high BMI significantly decreased the flexion range in the hip and knee (26). In our study, we did not find any statistical difference in the range of motion of BMI results.

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Şahin, E. et al. reported that exercises were important and that muscle strength, endurance and range of motion increased with the help of exercises. In our study, we did not find any statistically significant difference in the normal range of motion of exercising (27).

In Bornemark's study titled Success Factors for E-Sports Games, when slow-playing games were compared with fast-playing games, fast-playing games usually require a high coordination and reaction time capacity. Meanwhile, while the reaction time of video game players decreased, their hand-eye coordination was found to increase and it was stated that the players gained more dexterity (28). Griffith et al. In the study named hand-eye motor coordination differences between e-sports players and non-players, when 31 video game users and 31 individuals who never played video games were compared, it was reported that the users had significantly better eye-hand motor coordination (29). In these studies, there were no data on range of motion, but studies on manual dexterity and eye coordination were conducted. In our study, we found a statistically significant difference in the range of motion of the participants depending on the sport status.

Kibler et al. In a study of 39 elite tennis players, shoulder joint internal rotation and external rotation range of motion were compared according to age. The included volunteer participants were divided into 14-16 years, 16-18 years and 18-21 years. As a result of this study, it was observed that internal rotation and total rotation range of motion decreased significantly with increasing age. In our study, we did not find a statistically significant difference in range of motion depending on age (30).

In a study by Anakwe et al, it was found that hand grip strength increased in parallel with forearm circumference measurements (31). Again, Stegink et al. compared hand grip strength and finger grip strength with anthropometric measurements and found that these forces were positively correlated with arm and forearm circumference measurements (32). In our study, a statistically significant difference was found between wrist circumference measurement and manual muscle test.

Conclusions

As a result of our study, the normal range of motion due to computer use in healthy individuals is comparable to the duration of computer use. The range of motion observed in the wrist during daily activities increases with computer use. This angle value contributes positively to the better evaluation of activity limitations caused by various reasons in individuals who need wrist rehabilitation. We believe that our study will contribute to clinicians, researchers and the literature on the treatment of wrist fractures, analysis of the wrist and appropriate treatment of an unnatural range of motion.

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